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Inflation and Markups:
Theories and Evidence from the Retail Trade Sector

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August, 1991
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1 Introduction

In this paper I examine how retail markups are affected by high or volatile inflation. While interesting in its own right, this question is best understood in the light of recent work on the effects of inflation in imperfectly competitive markets. For instance, are inflationary episodes times when consumers' confusion about real prices leads to a rise in monopoly power, or do buyers react to price dispersion and variability by comparing more prices, so that competition intensifies ?

The theoretical literature, which is briefly reviewed in the next section, divides into two main categories: (i) models with costs of price adjustments leading to (S,s) rules, which deal with the effects of expected inflation; (ii) models of signal-extraction or learning from prices, which deal with stochastic inflation and inflation uncertainty. Both types of models ascribe a central role to imperfect competition (in that sense they can be termed neo-Keynesian) and in particular to consumer search. Their main lesson is that once strategic interactions and search are properly taken into account, one can not take for granted that higher inflation, or even more uncertain inflation, generate welfare losses. Of crucial importance is their effect on market power, which is shown to depend on the size of informational costs. This has an important implication: empirical studies showing a positive relationship between inflation and price dispersion, or even between average inflation and inflation uncertainty, are not sufficient to draw conclusions about the costs of inflation. These variables must themselves be linked to magnitudes to which are directly relevant for welfare, and in particular to the intensity of competition.

This is what I do in this paper, by constructing a series for the markup in the U.S. retail trade sector and examining how it varies with anticipated inflation, unanticipated inflation, and inflation uncertainty. The markup is derived following the methodology of Rotemberg and Woodford (1991), extended to take account of intermediate inputs. I focus on retail trade, because it is presumably where search is most relevant.

2 Some theoretical models

2.1 Expected inflation

Monopolistic firms. The effects of anticipated inflation have been studied using models where firms face fixed costs of adjusting prices, and operate in an environment of steady inflation. The first assumption reflects the fact that some nominal rigidity is required for expected inflation to matter; the second is for simplicity. The firms then optimally follow an (S,s) rule, keeping their nominal price constant while their real price declines from a ceiling S to a floor $s < S$, and then adjusting back to S for a new cycle (Sheshinski and Weiss (1977)). As inflation rises, S increases and s decreases: price adjustments become larger, and generally more frequent.

This effect of inflation on real prices generates a steady-state run Phillips-curve: a firm's average output over time, hence also the aggregate output of many firms whose price adjustments are staggered, varies with the rate of inflation -and so does aggregate welfare. Unfortunately, the slope of this Phillips curve depends on elements on which little theoretical or empirical information is available: (i) the skewness of the profit function, which determines whether S increases faster or slower than s decreases (Naish (1986), Kuran (1986)); (ii) the curvature of the demand function, which determines the output consequences of these changes, through Jensen's inequality (Konieczny (1990)); (iii) discounting, which makes the initial price S more sensitive to inflation than the final price s, so that inflation tends to reduce average output (Danziger (1988)). Thus perhaps the main conclusion to be drawn here is a warning against the use of restrictive functional forms.

Market equilibrium with consumer search. Incorporating competition between firms and taking account of consumer behavior generates some new insights. First, the effects discussed above are reinforced by the strategic complementarity of firms' prices. More interestingly, the price dispersion resulting from the staggering of (S,s) rules offers consumers a scope for search, which increases with the rate of inflation (Bénabou (1988),(1991); Diamond (1991)). This in turn has two opposite effects on welfare. First, when inflation is high more resources will be spent on search; this is a cost of inflation which is frequently men-

tioned . On the other hand, the increased search pressure implies more competition in the market, pushing real prices S and s down, output and welfare up. In the long run, it also causes some firms to exit, thus reducing the dissipation of rents on fixed costs which characterizes monopolistic competition; on the other hand, having fewer firms in the market may increase the cost or length of search. The overall impact on welfare depends on consumer preferences and market structure, and in particular on whether search costs are small (allowing consumers to take full advantage of the widened price range) or large.

2.2 Inflation uncertainty

Perfect competition and signal-extraction. As made clear by the models of Lucas (1973), Barro (1976) or Cuckierman (1979), stochastic inflation or money growth can generate distorsions even in the absence of nominal rigidities, by acting as a source of noise which causes agents to misperceive relative prices. These models, however, share two unsatisfactory features. First, they rely on an extreme asymmetry between informational costs within a market (zero) and across markets (infinite) to sustain perfect competition in spite of imperfect price information; realistically, informational costs should imply market power. Secondly, they deny agents the possibility to acquire additional information, for instance through search.

Imperfect competition and endogenous information. In imperfectly competitive markets, prices are not Walrasian to start with, and the issue is again whether inflation uncertainty reinforces or weakens monopoly power; this in turn hinges on how it affects the inferences which consumers draw from prices, and the resulting incentives to gather more information (Bénabou and Gertner (1990), Dana (1990), Fishman (1990)). On one hand sellers, being better informed, may use the inflationary noise as a cover behind which to increase their average markups. On the other hand, consumers may react to more noisy prices by gathering more price quotations. Because the search decision introduces a non-convexity, they might end up better informed in equilibrium, forcing prices and markups down. Bénabou and Gertner (1990) formalize these effects in a model of search with learning, where firms are subject to both idiosyncratic and aggregate (inflationary) costs shocks, and where consumers must infer from prices whether or not it is worth searching for a better deal. The model shows that inflation uncertainty has two effects. First, by

making prices more correlated across firms, it induces consumers to search less in response to high prices, but more in response to low prices. Thus through this "correlation effect", inflation uncertainty increases consumers' reservation price if it was already high (because of high search costs), but decreases it if it was already low (low search costs). Secondly, a higher variance of inflationary shocks means a higher variance in the distribution of unobserved prices, even once conditioned on observed prices; this "variance effect" always raises the option value of search and tends to lower reservation prices, hence also markups. The overall effect of inflation uncertainty on markups and welfare thus depends on the size of search costs. Where they are low, inflation uncertainty can be beneficial by inducing search, but where they are high it is detrimental. This is another reason why I shall focus the empirical analysis on the retail sector, since it is presumably where search costs are most important, compared to the value of purchases.

Repeat purchases and information obsolescence. Another line of thought linking stochastic inflation to decreased market efficiency involves repeat purchases. The idea is that when inflation is volatile, consumers' information about the prices of sellers from whom they purchased previously becomes outdated more rapidly. As result, they are less well informed, allowing firms to charges higher prices or to be less efficient. This simple idea is in fact quite difficult to formalize rigorously, but some progress along these lines has been made (Van Hoomissen (1982), Tommasi (1991)).

2.3 Implications

The same fundamental lesson emerges from the two types of models: some of the most important effects of inflation and inflation uncertainty involve their impact on market power, through agents' incentives to search. This places substantial limitations on the welfare conclusions which can be drawn from empirical studies linking higher rates of inflation to increased price dispersion at the micro level (e.g. Domberger (1987), Danziger (1987), Van Hoomissen (1988)), or even to a higher variance of inflation (e.g. Engle (1983), Ball and Cecchetti (1990)). While such investigations provide valuable information about price-setting and the inflationary process, their efficiency implications hinge on a crucial "missing link": the impact of inflation-generated price dispersion or uncertainty on competition. To provide a first assessment

of these effects, I shall examine the behavior of markups.

3 Constructing the markup series

3.1 Theory.

Consider a monopolistically competitive industry, composed of firms with production function:

$$Y = min\{F(H,K) - \Phi,\ M/\gamma\} \tag{1}$$

where H is labor hours, K is capital, and M intermediate inputs, which are required in fixed proportion to output. F(H,K) is an increasing, concave function which is homogeneous of degree one, while Φ represents fixed costs generating increasing returns to scale. Cost minimization implies and $M = \gamma Y$ and:

$$\frac{pF_H}{w} = \frac{pF_K}{r} = \lambda. \tag{2}$$

where p is the output price, w the wage, and r the interest rate. The firm's markup μ, defined as the ratio of output price to marginal cost, is therefore:

$$\frac{1}{\mu} = \frac{1}{\lambda} + s_M \tag{3}$$

where $s_M \equiv qM/pY = \gamma q/p$ denotes intermediate inputs' share in the value of output, and q their price; I denote similarly $s_H \equiv wH/pY$ and $s_K \equiv rK/pY$. Finally, entry leads to the elimination of pure profits: $pY = wH + rK + qM$, or: $s_H + s_K + s_M = 1$. Together with (2), this implies:

$$\frac{1}{\mu} = (1 - s_M) \cdot \frac{Y}{Y + \Phi} + s_M \tag{4}$$

which shows how the fixed costs Φ are reflected in the equilibrium markup. As shown by Hall (1986), (1988), monopoly power is also reflected in the relationship between variations in inputs and outputs:

$$\hat{y} = \mu \cdot (s_H \hat{h} + s_K \hat{k} + s_M \hat{m}) \tag{5}$$

where hatted variables denote log-deviations from trend, throughout the paper. The difference between the two sides of (5) is the true Solow residual, which for simplicity I take here to be zero. A similar type of accounting holds for value added data. Nominal value added is: $V = wH + rK = pY - qM = pY(1 - s_M)$. Deflating it by the Divisia index ρ, with $\hat{p} \equiv (1 - s_M)\hat{\rho} + s_M\hat{q}$, yields changes in real value added: $\hat{a} \equiv \hat{v} - \hat{\rho} = \hat{y} = \mu \cdot (s_H\hat{h} + s_K\hat{k} + s_M\hat{m})$. Hence:

$$\hat{a} = \mu' \cdot (s'_H\hat{h} + s'_K\hat{k}) \qquad \text{with} \qquad \mu' = \frac{\mu(1 - s_M)}{1 - \mu s_M} \tag{6}$$

and $s'_H \equiv s_H/(1 - s_M)$, $s'_K \equiv s_K/(1 - s_M) = 1 - s'_H$ denoting labor and capital's shares in value added. Taking markups to be constant over time, Hall (1988) estimates equation (6) on annual data (1953-1984) for two-digit industries, and obtains sectoral estimates of μ. For the retail sector, on which I focus below, $\bar{\mu}' = 2.355$, corresponding to $\bar{\mu} = 1.403$.

Since the issue here is how markups vary with inflation, the assumption that μ is constant is clearly inadequate. I shall therefore follow Rotemberg and Woodford (1991) in using Hall's estimate as an average or steady-state value, and constructing from the data a series for deviations of the markup from this level. The variations in the markup around $\bar{\mu}$ are obtained from (3):

$$\hat{\mu} = \frac{\hat{\lambda} - \lambda s_M \cdot \widehat{s_M}}{1 + \lambda s_M} = \frac{1 - s_M}{1 + (\mu' - 1)s_M} \cdot (\hat{\lambda} - \frac{s_M}{1 - s_M}\mu' \cdot \widehat{s_M}). \tag{7}$$

By (1), $\widehat{s_M} = \hat{q} - \hat{p} = (1 - s_M)(\hat{q} - \hat{\rho})$. As to $\hat{\lambda}$, it is obtained by log-linearizing the first-order condition $pF_H/w = \lambda$, using for F a Cobb-Douglas specification: $F(H,K) = H^\alpha K^{1-\alpha}, 0 < \alpha < 1$; thus:

$$\hat{\lambda} + \hat{w} - \hat{p} = (1 - \alpha)(\hat{k} - \hat{h}) = s'_K(\hat{k} - \hat{h}), \tag{8}$$

since $s_H = (wH/pF)((Y + \Phi)/Y) = (\alpha/\lambda)((Y + \Phi)/Y) = \alpha(1 - s_H)$, so $s'_H = \alpha = 1 - s'_K$. Together, (6) and (8) imply:

$$\hat{\lambda} = \hat{a} - \hat{h} - \hat{w} + \hat{\rho} - (\mu' - 1) \cdot (s'_H\hat{h} + s'_K\hat{k}) + \hat{p} - \hat{\rho}, \qquad \text{or:}$$

$$\hat{\lambda} = -\widehat{s'_H} - (\mu' - 1) \cdot (s'_H\hat{h} + s'_K\hat{k}) + s_M(\hat{q} - \hat{\rho}) \tag{9}$$

This expression is the markup calculated by Rotemberg and Woodford, except for the addition of the last term, which corrects for the fact the real wage implicit in labor's share s'_H uses the value added deflator instead of the output price. Moreover, to obtain the true markup for an industry using intermediate inputs, one must take account not only of the variations in $\lambda = pF_H/w$, but also in s_M, as shown in (7). Hence, finally:

$$\hat{\mu} = \frac{1 - s_M}{1 + (\mu' - 1)s_M} \cdot (-\widehat{s'_H} - (\mu' - 1) \cdot (s'_H \hat{h} + s'_K \hat{k} + s_M(\hat{q} - \hat{p}))) \tag{10}$$

where μ', s'_H, s'_K and s_M can be replaced by their steady-state values $\bar{\mu}', \bar{s}'_H, \bar{s}'_K$ and $\bar{s}_M$. If there are no intermediate inputs ($\gamma = 0$), then $s_M \equiv 0$ and $\hat{\mu}$ equals $-\widehat{s'_H}$, plus the Rotemberg-Woodford correction for monopoly power. If there are constant returns to scale, $\Phi = 0$, then $\mu = \mu' \equiv 1$ by (4) and (6), and $\hat{\mu} = (1 - s_M) \cdot \hat{\alpha} = 0$.

3.2 Data

I use annual data for real and nominal value added, hours, capital, and wages in the retail trade sector, from 1947-1985. It is the same as in Hall (1988), and similar to that used by Rotemberg and Woodford (1991) for other sectors (they do not look at retail trade). For the price q of the intermediate inputs used by the retail sector I use the producer price index for finished goods.[1] I set $\bar{s}'_H = 1 - \bar{s}'_K$ equal to 0.579, the average share of labor in value added over the sample; for $\bar{s}_M$, the average share of intermediate inputs in the value of output, I use 0.5, which is typical of the literature. Finally, I set $\bar{\mu}'$ equal to Hall's estimate of 2.355, corresponding to an output price exceeding full marginal cost by 40 per cent.

4 Sources of variations in markups

Inflation. I start by plotting the markup series constructed above, together with the rate of inflation. *Figures 1a and 1b*, which use the GNP deflator and the urban CPI respectively, convey the same clear

[1] I also implemented the alternative formulation of (10) which involves $\tilde{p}$ and $\tilde{q}$ instead of $\hat{p}$ and $\hat{q}$, using for the output price p the deflator of the retail sales series from Citibase; it gave very similar results.

Figure 1a: Inflation and Markups

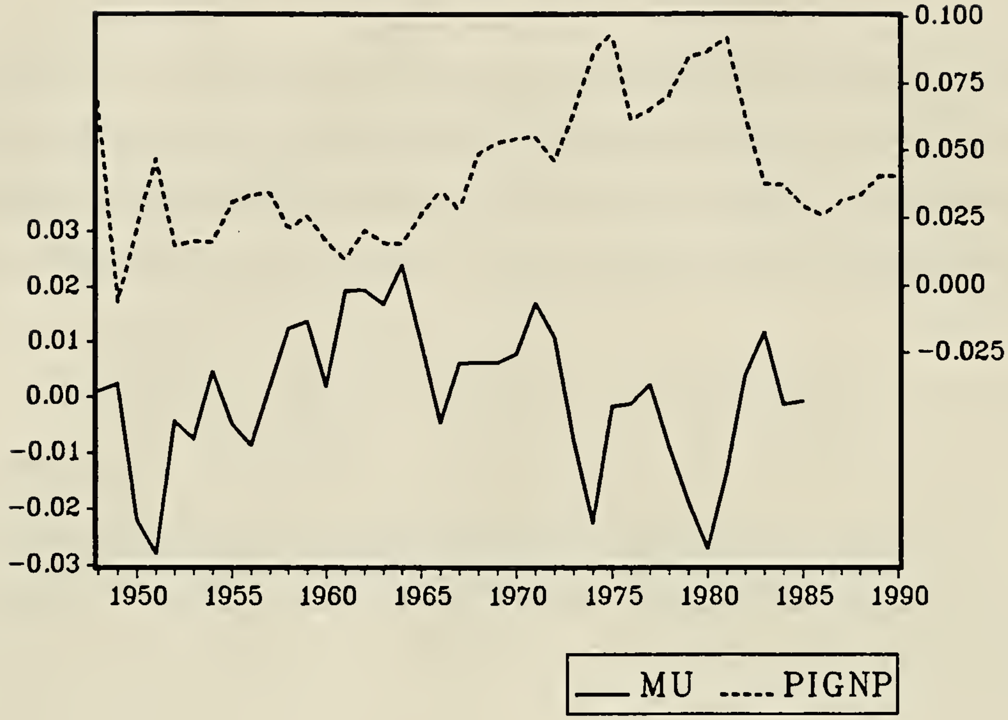
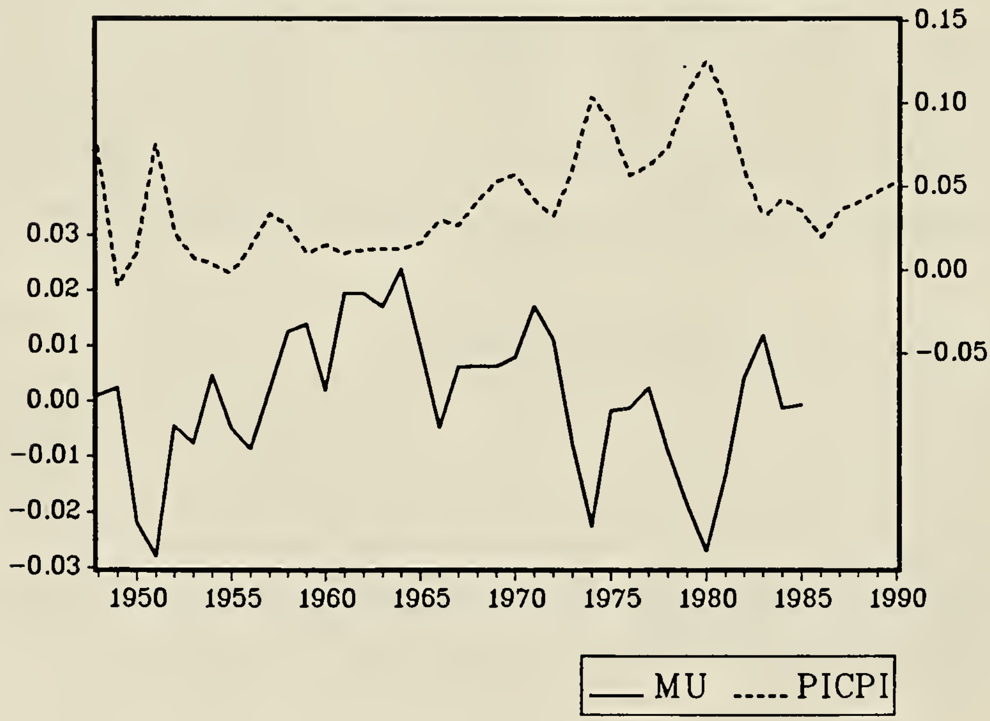


Figure 1b: Inflation and Markups



message: higher inflation is associated to lower markups. Using the PPI gives similar results. This picture is confirmed by the regression shown in the first column of *Table 1*, where inflation has a small but significantly negative effect on the markup: a 10 point rise in inflation reduces the markup by 3.59 per cent. Starting from the steady state, it means that price falls from 40.3 per cent above marginal cost to 35.3 per cent above marginal cost.

The business cycle. To properly identify the effect of inflation, one must control for the influence of the business cycle on markups. This is the focus of Rotemberg and Woodford's (1991) study, and I shall use the same variables as them: current industry demand, whose variations are measured by $\hat{y} = \hat{a}$, and the expected present value of future demand:

$$\hat{x}_t = E_t(\sum_{j=0}^{\infty} \delta^j \cdot \hat{y}_{t+j+1}) \tag{11}$$

where a constant discount factor $\delta = 0.9$ is used for simplicity.[2] In oligopolistic markets where firms sustain collusion through trigger strategies, high current demand increases a firm's temptation to deviate, while high future demand increases the penalty, namely the collusive profits which will be foregone due to the ensuing price war. Equilibrium markups should thus decrease with $\hat{y}$ and increase with $\hat{x}$. In "customer markets", on the contrary, market share reacts only slowly to price differentials. Thus temporarily high demand leads firms to raise prices without much fear of customer loss, while the expectation of high future demand leads them to compete harder now, in order to build up a clientele which can be profitably exploited later. Hence equilibrium markups should now increase with $\hat{y}$ and decrease with $\hat{x}$. Since the retail trade sector is presumably better described as a monopolistically competitive customer market than as an oligopoly, these are the effects one would expect to observe.

The regressions incorporating the business cycle variables are given in columns (2) and (3) of *Table 1*.

[2] To make the results comparable to Rotemberg and Woodford's, I use for $\hat{x}$ the same proxy as them, obtained by projecting sectoral demand on its lagged value and on (detrended) real GNP: $\hat{y}_t = c_1 \cdot \hat{y}_{t-1} + c_2 \cdot \widehat{gnp}_t + \nu_t$, together with an AR(1) process for real GNP: $\widehat{gnp}_t = c_3 \cdot \widehat{gnp}_{t-1} + \eta_t$, where ν_t and η_t are random errors. These assumptions lead to the expected value: $\hat{x}_t = \frac{\hat{y}_t}{1-\delta c_1} + \frac{\delta c_2 c_3 \cdot \widehat{gnp}_t}{(1-\delta c_1)(1-\delta c_3)}$.

Table 1: Markups, Inflation, and the Business Cycle

1948-1985; π = inflation in the GNP deflator.

Heteroskedasticity-consistent t-statistics in parenthesis

	(1)	(2)	(3)
π	-0.359	-0.267	-0.381
	(-3.323)	(-2.708)	(-5.847)
$\hat{x}$		0.131	0.157
		(4.768)	(7.240)
$\hat{y}$		-0.333	-0.315
		(-6.596)	(-5.464)
ar(1)			0.111
			(0.619)
ar(2)			-0.296
			(-2.307)
$\mathrm{tr}\times 10^3$	0.451	0.369	0.679
	(1.645)	(1.434)	(4.756)
$\mathrm{cst.}\times 10^3$	6.404	3.858	1.467
	(1.502)	(1.120)	(0.635)
$\bar{R}^2$	0.286	0.599	0.793
DW	0.957	1.366	2.109

Inflation's effect is again significantly negative, especially when I correct for first and second order serial correlation in the residuals, in response to the low Durbin-Watson statistics of columns (1) and (2); see column (3).[3]

The other notable result is that the cyclical variations in the markup clearly reject the simple customer market model, and are instead consistent with the implicit collusion model: $\hat{\mu}$ falls with $\hat{y}$ and increases with $\hat{x}$, both effects being statistically significant. These results, however, could also be explained by a more complex customer market model than the one described above. First, if demand becomes (sufficiently) more price-elastic at higher levels, then $\hat{\mu}$ will fall with $\hat{y}$; such an effect may arise from non-homothetic individual preferences (Rotemberg and Woodford (1991)), or from cyclical changes in the population of buyers (Bils (1989)). Secondly, $\hat{\mu}$ may rise with $\hat{x}$ if anticipated increases in demand make firms want to invest in some form of capital (R.& D., physical equipment, advertising) which, due to borrowing constraints, they can only finance by raising prices and short-term profits, effectively drawing down their "customer capital" (Gottfries (1991)).

5 Average inflation and inflation variability

Having shown that inflation matters, the next step is to try and understand how. Is the level of inflation relevant in itself, suggesting the presence of nominal rigidities such as those leading to (S,s) rules ? Or does inflation matter only through its variability, operating as a source of noise in agents' price information ? To try and answer these questions, I split the 1948-1985 sample into eight subperiods of five years each,[4] and compute for each of them the average $\bar{\pi}$ and standard deviation $\bar{\sigma}_\pi$ of the inflation rate. I then regress $\hat{\mu}$ on these variables, $\pi - \bar{\pi}$, $\hat{y}, \hat{x}$, a trend and a constant. This procedure is consistent with the idea that the parameters of the inflation process affect market power in steady-state, as in the models of Section 2,

[3]All the regressions discussed in this and the following sections were also run in first differences instead of levels, with very similar results.

[4]Except for the first one, 1948-1950. Using thirteen three-year subperiods gave very similar results.

Table 2: Inflation, Average Inflation and Inflation Variability

1948-1985; heteroskedasticity-consistent t-statistics in parenthesis

	GNP		CPI		PPI	
$\bar{\pi}$	-0.329	-0.434	-0.107	-0.263	-0.135	-0.221
	(-2.433)	(-4.162)	(-0.747)	(-2.060)	(-1.471)	(-3.501)
$\pi - \bar{\pi}$	-0.241	-0.337	-0.253	-0.280	-0.168	-0.198
	(-2.057)	(-3.426)	(-3.698)	(-4.028)	(-4.975)	(-5.320)
$\bar{\sigma}_{\pi}$	0.169	0.130	-0.348	-0.212	-0.036	0.062
	(0.435)	(0.549)	(-1.235)	(-0.924)	(-0.258)	(0.565)
$\hat{x}$	0.143	0.164	0.065	0.102	0.120	0.172
	(4.280)	(5.869)	(1.695)	(2.829)	(2.963)	(5.694)
$\hat{y}$	-0.337	-0.311	-0.237	-0.238	-0.286	-0.328
	(-5.427)	(-4.436)	(-3.581)	(-3.088)	(-5.185)	(-5.596)
ar(1)		0.161		0.170		-0.020
		(0.880)		(0.898)		(-0.105)
ar(2)		-0.351		-0.324		-0.272
		(-2.322)		(-2.234)		(-1.909)
$\mathrm{tr}\times 10^3$	0.453	0.737	0.170	0.575	0.209	0.496
	(2.097)	(3.913)	(0.627)	(2.385)	(0.879)	(3.241)
$\mathrm{cst.}\times 10^3$	2.400	0.815	8.193	2.757	1.186	-4.720
	(0.639)	(0.246)	(1.512)	(0.619)	(0.315)	(-1.122)
$\bar{R}^2$	0.539	0.737	0.607	0.777	0.655	0.807
DW	1.371	2.135	1.314	1.926	1.429	1.922

while business cycle variables and individual inflationary shocks generate deviations from this value.

The results, presented in *Table 2*, are again clear cut: both average inflation and current deviations from this average value lead to reductions in the markup. This is true whether inflation is measured from the GNP deflator, the CPI or the PPI, especially after correcting for serial correlation in the residuals. Most interestingly, inflation variability has no measurable impact: its estimated coefficient is very small, changes sign across regressions and is never statistically significant. Finally, the effects of $\hat{y}$ and $\hat{x}$ are unchanged from those of Table 1, and equally significant.

6 Expected inflation and inflation uncertainty

In this section I make a more sophisticated attempt to identify the effects of anticipated inflation, unanticipated inflationary or deflationary shocks, and inflation uncertainty. Indeed, the five-year averages, deviations and variances used above provide only crude proxies for these variables, and valuable information may be lost by averaging. I therefore estimate an ARCH forecasting equation (Engle (1982)) for inflation, generating mutually consistent series for expected inflation $E_{-1}(\pi)$, the inflation forecast error $\pi - E_{-1}(\pi)$, and for the latter's standard deviation $SD_{-1}(\pi)$. The specific model used is :

$$\pi_t = Z_t \cdot \beta + \epsilon_t \quad ; \quad \epsilon_t \sim \mathcal{N}(0, \sigma_t), \qquad \sigma_t^2 = \alpha_0 + \alpha_1 \epsilon_{t-1}^2 + \alpha_2 \epsilon_{t-2}^2 \tag{12}$$

where Z_t is a list of variables used to forecast next year's inflation. I use two such lists, leading to the markup regressions presented in *Tables 3a and 3b*. The first one consists of π_{t-1} and π_{t-2}, a trend and a constant. The second includes in addition the lagged growth rates of the import deflator and of the hourly wage in manufacturing. The two specifications lead to very similar results.[5]

[5]Other lists for Z_t gave analogous results. As in Engle (1983), I ensure that the estimated variance is always positive by constraining the coefficients to decline linearly: $(\alpha_2, \alpha_2) = \beta \cdot (2, 1)$. I estimate α_0 and β by two iterations of generalized least squares (Engle (1982)) rather than by full-information maximum likelihood, for simplicity.

Figure 2a: Expected Inflation and Markups

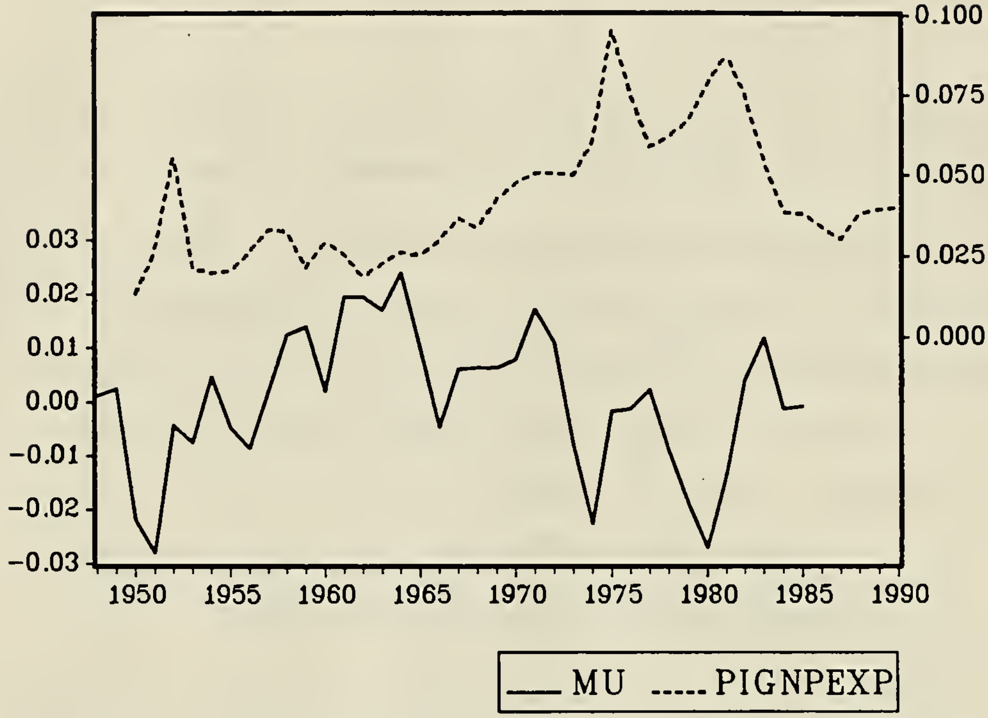


Figure 2b: Unexpected Inflation and Markups

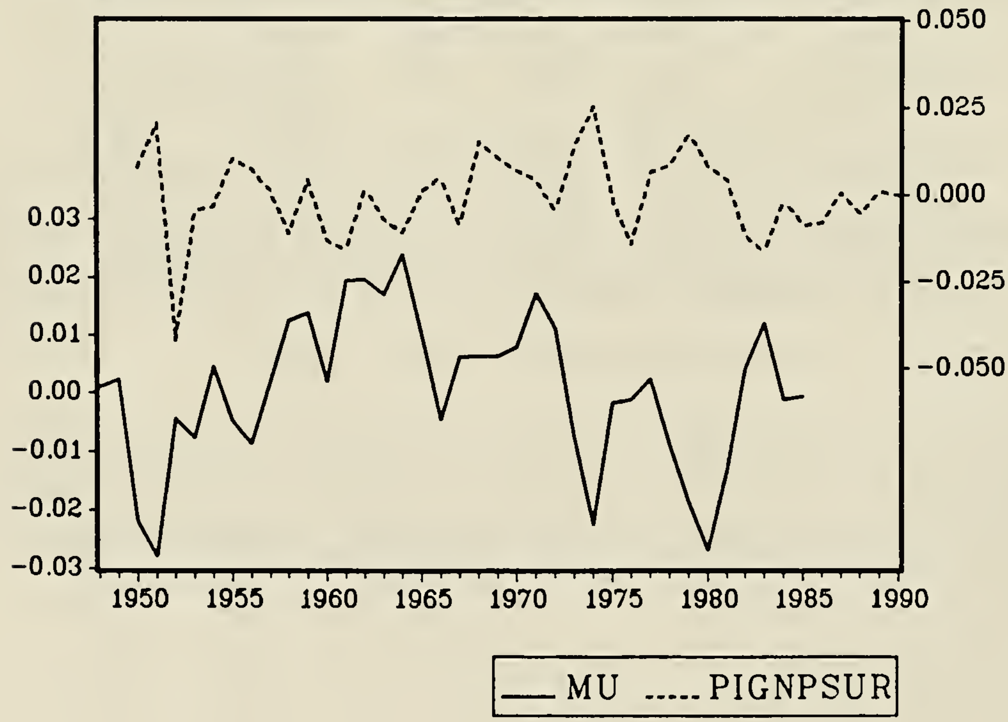


Figure 2c: Inflation Uncertainty and Markups

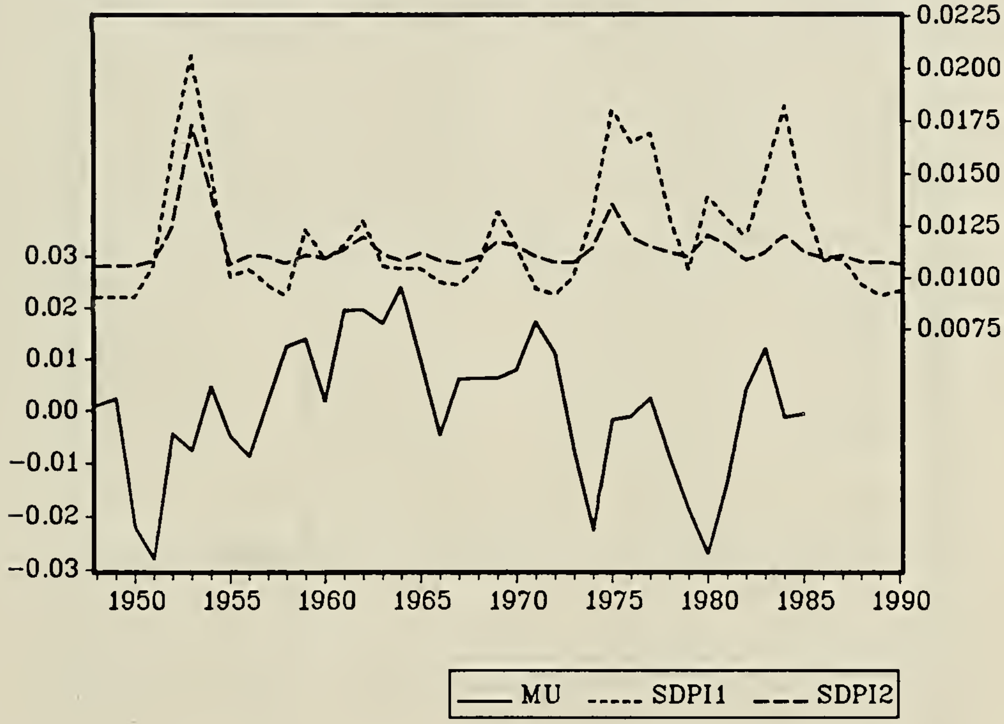


Table 3a: Expected Inflation, Unexpected Inflation and Inflation Uncertainty

1948-1985; first list of forecasting variables used.

Heteroskedasticity-consistent t-statistics in parenthesis.

	GNP		CPI		PPI	
$E_{-1}(\pi)$	-0.355	-0.386	-0.169	-0.198	-0.210	-0.234
	(-4.635)	(-3.918)	(-3.231)	(-2.477)	(-6.652)	(-4.528)
$\pi - E_{-1}(\pi)$	-0.425	-0.346	-0.386	-0.357	-0.187	-0.176
	(-4.256)	(-2.928)	(-7.477)	(-5.299)	(-6.636)	(-4.303)
$SD_{-1}(\pi)$	0.293	0.095	-0.382	-0.491	-0.010	-0.024
	(0.910)	(0.179)	(-1.362)	(-1.406)	(-0.117)	(-0.169)
$\hat{x}$	0.168	0.152	0.114	0.113	0.154	0.156
	(7.658)	(4.933)	(4.670)	(3.363)	(7.637)	(6.121)
$\hat{y}$	-0.349	-0.316	-0.265	-0.264	-0.316	-0.312
	(-6.993)	(-4.540)	(-4.696)	(-3.711)	(-6.687)	(-5.676)
ar(1)		0.118		0.326		0.032
		(0.563)		(1.651)		(0.156)
ar(2)		-0.176		-0.238		-0.154
		(-0.875)		(-1.290)		(-0.735)
$\mathrm{tr} \times 10^3$	0.673	0.624	0.434	0.425	0.480	0.477
	(5.526)	(3.097)	(3.317)	(1.858)	(4.334)	(3.229)
$\mathrm{cst.} \times 10^3$	-3.494	1.985	4.437	8.062.	-2.640	-1.015
	(-0.654)	(0.268)	(0.633)	(0.925)	(-0.536)	(-0.164)
$\bar{R}^2$	0.716	0.666	0.765	0.766	0.795	0.772
DW	1.727	2.035	1.504	2.113	1.839	2.038

Table 3b: Expected Inflation, Unexpected Inflation and Inflation Uncertainty

1948-1985; second list of forecasting variables used.

Heteroskedasticity-consistent t-statistics in parenthesis.

	GNP		CPI		PPI	
$E_{-1}(\pi)$	-0.361	-0.359	-0.249	-0.274	-0.181	-0.201
	(-6.340)	(-4.053)	(-6.679)	(-4.217)	(-7.532)	(-4.554)
$\pi - E_{-1}(\pi)$	-0.453	-0.418	-0.366	-0.363	-0.202	-0.197
	(-4.304)	(-3.446)	(-6.959)	(-5.284)	(-8.585)	(-5.080)
$SD_{-1}(\pi)$	1.160	0.588	-0.111	-0.244	-0.038	-0.050
	(1.660)	(0.472)	(-0.558)	(-0.779)	(-0.437)	(-0.406)
$\hat{x}$	0.172	0.159	0.123	0.119	0.154	0.156
	(8.012)	(4.982)	(4.969)	(3.221)	(7.538)	(6.044)
$\hat{y}$	-0.351	-0.319	-0.306	-0.285	-0.309	-0.303
	(-7.250)	(-4.622)	(-5.400)	(-3.613)	(-6.775)	(-5.449)
ar(1)		0.092		0.364		0.069
		(0.441)		(1.893)		(0.348)
ar(2)		-0.120		-0.232		-0.144
		(-0.595)		(-1.306)		(-0.699)
tr$\times 10^3$	0.734	0.636	0.557	0.557	0.437	0.448
	(6.258)	(2.919)	(4.201)	(2.489)	(4.051)	(3.034)
cst.$\times 10^3$	-14.37	-5.217	-0.308	3.085	-2.027	-0.965
	(-1.474)	(-0.317)	(-0.050)	(0.391)	(-0.414)	(-0.171)
$\bar{R}^2$	0.727	0.670	0.742	0.748	0.795	0.763
DW	1.758	2.023	1.390	2.105	1.842	2.017

Figures 2a-2b illustrate the relationships between $\hat{\mu}$, $E_{-1}(\pi)$, and $\pi - E_{-1}(\pi)$. Inflation is measured using the GNP deflator and predicted using the second, larger list of forecasting variables; alternative choices give similar pictures. Both expected and unexpected inflation are quite clearly negatively correlated with the markup. *Figure 2c* plots the relationship between $\hat{\mu}$ and $SD_{-1}(\pi)$, for both lists of instruments; naturally the smaller information set leads to greater uncertainty. Inflation uncertainty surges up during the early fifties (as in Engle (1983)), at the time of the first oil shock, and in the early eighties during the Volcker deflation; no clear relationship to the markup is apparent.

The regressions shown in *Tables 3a* and *3b* confirm this picture, and reinforce the results of the previous section: whether measured from the GNP deflator, CPI or PPI, both expected inflation and unexpected inflationary shocks depress the markup, with an elasticity of about one-third, and a very high level of significance. By contrast, inflation uncertainty, defined as the standard deviation of the one-year ahead forecast error, has no measurable impact: the estimated coefficient is never statistically significant, and changes sign from one regression to the other. Finally, the effects of the business cycle variables $\hat{y}$ and $\hat{x}$ are identical to those appearing in Tables 1 and 2. Once again, correcting for serial correlation or estimating the equation in first differences leaves all the results unchanged.

7 Conclusion

Two clear conclusions emerge from this study. First, both expected and unexpected inflation have small but highly significant negative effects on the markups of the U.S. retail sector. Secondly, neither inflation variability nor inflation uncertainty seem to matter. These result are broadly consistent with equilibrium (S,s) models where higher trend inflation, by causing more price dispersion, promotes search and thus intensifies competition. They also suggest that signal-extraction, the obsolescence of price data and other informational considerations do not play any major role. Most importantly, they support the findings of many recent theoretical models that one of the most important welfare effects of inflation is its impact on market power.

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